

CLAIMS

What is claimed is:

1. A cycle slip detector adapted for use in a phase comparison circuit, comprising:
 - a cycle slip detection filter possessing a predetermined filter bandwidth and a predetermined high frequency cut-off, with said cycle slip detection filter receiving a phase difference generated by said phase comparison circuit and transforming said phase difference into a filtered phase difference;
 - a compensator communicating with said cycle slip detection filter, with said compensator compensating said magnitude based on a predetermined compensation response; and
 - a cycle slip occurrence detector communicating with said compensator, with said cycle slip occurrence detector comparing a compensated magnitude of said filtered phase difference to a predetermined cycle slip threshold and generating a cycle slip output if said compensated magnitude exceeds said predetermined cycle slip threshold.
2. The cycle slip detector of claim 1, wherein said cycle slip detection filter is a low pass filter.
3. The cycle slip detector of claim 1, wherein said cycle slip detection filter is a band pass filter.

4. The cycle slip detector of claim 1, wherein said predetermined high frequency cut-off is at about 8 Hz.

5. The cycle slip detector of claim 1, wherein said predetermined cycle slip threshold is about 0.5 radians.

6. The cycle slip detector of claim 1, wherein said cycle slip occurrence detector comprises:

an absolute value detector communicating with said cycle slip detection filter, with said absolute value detector generating an absolute value magnitude from said magnitude of said filtered phase difference; and

a comparator communicating with said absolute value detector, with said at least one cycle slip comparator detecting when said absolute value magnitude exceeds a predetermined cycle slip threshold.

7. The cycle slip detector of claim 1, wherein said cycle slip occurrence detector comprises:
- a positive comparator communicating with said compensator and detecting when a positive bipolar pulse peak in said filtered phase difference positively exceeds a predetermined positive cycle slip threshold; and
 - a negative comparator communicating with said compensator and detecting when a negative bipolar pulse peak in said filtered phase difference negatively exceeds a predetermined negative cycle slip threshold;
- wherein a slip output is generated when said positive comparator detects a positive bipolar pulse peak or said negative comparator detects a negative bipolar pulse peak.

8. The cycle slip detector of claim 1, wherein said cycle slip detector further comprises:

a cycle slip direction detector communicating with said positive comparator and said negative comparator, with said cycle slip direction detector generating a positive cycle slip output if a positive bipolar pulse peak occurs first in said bipolar pulse and if said bipolar pulse frequency is within a predetermined mid-frequency range, and conversely generating a negative cycle slip output if a negative bipolar pulse peak occurs first in said bipolar pulse and if said bipolar pulse frequency is within a predetermined mid-frequency range; and

a size estimator communicating with said compensator and with said cycle slip direction detector, with said size estimator generating a cycle slip size estimate based on a magnitude of said compensated, filtered phase difference if both peaks of a bipolar pulse are detected by said cycle slip direction detector.

9. The cycle slip detector of claim 1, wherein said cycle slip detector further comprises:

a positive comparator communicating with said cycle slip detection filter, with said positive comparator comparing a magnitude of said filtered phase difference to a predetermined positive cycle slip threshold and generating a positive cycle slip output if said magnitude positively exceeds said predetermined positive cycle slip threshold;

a negative comparator communicating with said cycle slip detection filter, with said negative comparator comparing a magnitude of said filtered phase difference to a predetermined negative cycle slip threshold and generating a negative cycle slip output if said magnitude negatively exceeds said predetermined negative cycle slip threshold;

a cycle slip direction detector communicating with said positive comparator and said negative comparator, with said cycle slip direction detector receiving said positive and negative cycle slip outputs, with said cycle slip direction detector generating a positive cycle slip output if a positive bipolar pulse peak occurs first in said bipolar pulse and if said bipolar pulse frequency is within a predetermined mid-frequency range, and conversely generating a negative cycle slip output if a negative bipolar pulse peak occurs first in said bipolar pulse and if said bipolar pulse frequency is within said predetermined mid-frequency range; and

a size estimator communicating with said compensator and with said cycle slip direction detector, with said size estimator generating a cycle slip size estimate based on a magnitude of said compensated, filtered phase difference if both peaks of a bipolar pulse are detected by said cycle slip direction detector.

10. A cycle slip detection method for detecting a cycle slip in a phase comparison circuit, comprising the steps of:

filtering out phase difference frequency components above a predetermined high frequency cut-off to produce a filtered phase difference; and

detecting a cycle slip in said filtered phase difference and generating a cycle slip output if a filtered phase difference magnitude exceeds a predetermined cycle slip threshold.

11. The method of claim 10, further comprising a step of compensating a magnitude of said filtered phase difference based on a predetermined compensation response before said detecting step.

12. The method of claim 10, wherein said detecting step further comprises:

compensating a magnitude of said filtered phase difference based on a predetermined compensation response to produce a compensated magnitude;

generating an absolute value magnitude from said compensated magnitude;

detecting when said absolute value magnitude exceeds a predetermined cycle slip threshold; and

generating a cycle slip output.

13. The method of claim 10, wherein said detecting step further comprises:
- compensating a magnitude of said filtered phase difference based on a predetermined compensation response to produce a compensated magnitude;
 - detecting when a positive bipolar pulse peak in said filtered phase difference positively exceeds a predetermined positive cycle slip threshold; and
 - detecting when a negative bipolar pulse peak in said filtered phase difference negatively exceeds a predetermined negative cycle slip threshold;
- wherein a cycle slip output is generated if a positive bipolar pulse peak or a negative bipolar pulse peak are detected.
14. The method of claim 10, further comprising a step of detecting a cycle slip direction.

15. The method of claim 10, further comprising the steps of:

detecting a positive bipolar pulse peak in said filtered phase difference if a filtered phase difference magnitude positively exceeds a predetermined positive cycle slip threshold;

detecting a negative bipolar pulse peak in said filtered phase difference if a filtered phase difference magnitude negatively exceeds a predetermined negative cycle slip threshold;

generating a positive cycle slip output if said positive bipolar pulse peak occurs before a corresponding negative bipolar pulse peak;

generating a negative cycle slip output if said negative bipolar pulse peak occurs before said positive bipolar pulse peak; and

generating a positive cycle slip output if a positive bipolar pulse peak occurs first in said bipolar pulse and if said bipolar pulse frequency is within a predetermined mid-frequency range, and conversely generating a negative cycle slip output if a negative bipolar pulse peak occurs first in said bipolar pulse and if said bipolar pulse frequency is within a predetermined mid-frequency range.

16. The method of claim 15, wherein said generating steps do not occur if said negative and positive bipolar pulse peaks are outside a mid-frequency region.

17. The method of claim 15, wherein said cycle slip size and positive cycle slip output and said negative cycle slip output are used to correct a cycle slip occurrence.

18. The method of claim 15, wherein said cycle slip size and positive cycle slip output and said negative cycle slip output are stored in order to accumulate a cycle slip correction factor.

19. The method of claim 15, further comprising the step of estimating a cycle slip size based on a magnitude of said compensated, filtered phase difference if both peaks of a bipolar pulse are detected.